Cryogenic Sapphire Oscillators and Applications

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Cryogenic sapphire oscillators (CSO) developed at the University of Western Australia (UWA) have now been in operation around the world continuously for many years. Such oscillators, due to their excellent spectral purity are essential for interrogating atomic frequency standards at the limit of quantum projection noise; otherwise aliasing effects will dominate the frequency stability due to the periodic sampling between successive interrogations of the atomic transition. Other applications, which have attracted attention in recent years, include tests on fundamental principles of physics, such as tests of Lorentz invariance, and results on a rotating pair of oscillators have put some of the best limits on Lorentz violating parameters within the Standard Model Extension (SME) and the Robertson-Mansouri-Sexl (RMS) frameworks.

In this work we will summarize the major past highlights of the technology and present our most recent results, which will include performance of the oscillators on the short and long term. We will also discuss our future research directions, including our upgrade to our Lorentz Invariance test, other tests of fundamental physics and our plans to use cryogenic oscillators in high precision radio astronomy.